

The Life Cycle of a CD or DVD

You listen to them on your stereo, play them in your computer, or watch movies on them. Compact discs (CDs) and their faster cousin, digital video discs (DVDs) are everywhere! Only a few millimeters thick, they provide hours of entertainment and hold huge volumes of information.

Do you ever stop to think about how CDs and DVDs are made, what materials are used, or what happens to these discs when you don't want them any more? Making products like CDs and DVDs consumes natural resources, produces waste, and uses energy. By learning about product life cycles, you can find out how to reduce the environmental impacts and natural resource use associated with products you use every day. When you understand these connections, you can make better environmental choices about the products you use, and how you dispose of them.

Follow the life cycle of a CD or DVD on this poster to learn more about how these products are made and how you can help reduce their environmental impacts.

Disposal

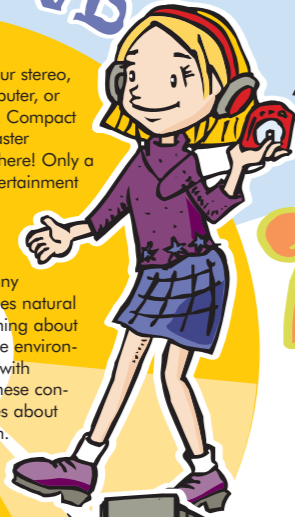
Only dispose of your discs when you have no other choice. Always try to share, donate, or trade your discs or drop them off at an appropriate recycling center. CDs and DVDs that are thrown away waste energy and result in lost valuable resources.

Purchasing Decisions

You constantly make decisions about buying products. One of your decisions probably involves weighing how much you want a product against how much it costs. This poster provides information to help you become a more environmentally aware consumer by describing the materials and energy consumption required to make CDs and DVDs. You should factor this information into your buying decisions and understand that nearly all of your choices have some environmental trade-offs. You might also want to consider whether the information you think you need on disc is actually available on the Internet. If it is, you might not need to buy the disc at all! Thinking about these issues will make you a more informed consumer and will help you make decisions that help to protect and preserve our environment.

Designing for the Environment

For a product to come into existence, it must be designed. And that design can have as much of an impact on the environment as any other step in a product's life cycle. For example, designers can plan for a product to be easily made from recycled materials, thus reducing the need to mine or gather raw materials. Most industries, including high-tech industries, have developed voluntary standards that many manufacturers follow when designing and manufacturing new products. These standards help make products as environmentally sound as is technologically possible. These standards also change as rapidly developing new technologies become available.



1 Materials Acquisition

CDs and DVDs are made from many different materials, each of which has its own separate life cycle involving energy use and waste. They include:

- Aluminum—the most abundant metal element in the Earth's crust. Bauxite ore is the main source of aluminum and is extracted from the Earth.
- Polycarbonate—a type of plastic, which is made from crude oil and natural gas extracted from the Earth.
- Lacquer—made of acrylic, another type of plastic.
- Gold—a metal that is mined from the Earth.
- Dyes—chemicals made in a laboratory, partially from petroleum products that come from the Earth.
- Other materials such as water, glass, silver, and nickel.



2 Materials Processing

Most mined materials must be processed before manufacturers can use them to make CDs or DVDs. For example:

- Bauxite ore is processed into a substance called "alumina" by washing, crushing, dissolving, filtering, and harvesting the materials. Alumina is then turned into aluminum through a process called "smelting." Then the metal is shaped, rolled, or made into a cast.
- To make plastics, crude oil from the ground is combined with natural gas and chemicals in a manufacturing or processing plant.



Fun Fact

More than 5.5 million boxes of software go to landfills and incinerators, plus people throw away millions of music CDs each year!



As with most stages of product life cycles, even recycling has environmental trade-offs. CD and DVD recycling is now an emerging technology, which means that many companies are not yet capable of recycling these discs. So, while recycling CDs and DVDs saves natural resources, the trade-off comes from the amount of fuel and energy that's consumed to transport discs long-distances to an appropriate recycling facility.

Most CD recycling companies only accept large stockpiles of old, damaged, or unused CDs and DVDs from businesses. A few companies will accept smaller quantities of discs mailed by individuals. Once the recyclers receive the CDs, they separate the packaging materials, manuals, and CDs for individual recycling processes. You might consider contacting a CD recycling company on behalf of your school or school district—collecting CDs for reuse could be a good school or community fundraising project. Check your local phone book or search the Internet for a list of recyclers, and be sure to have one in place before you begin collecting CDs for recycling.

- Automotive industry parts.
- Raw materials to make plastics (Discs are ground into a gravel-like substance, which is sold to companies that melt it down and convert it to plastic).
- Office equipment.
- Alarm boxes and panels, street lights, and electrical cable insulation.
- Jewel cases.



3 Recycling

CDs can be recycled for use in new products. Specialized electronic recycling companies clean, grind, blend, and compound the discs into a high-quality plastic for a variety of uses, including:

Reuse, Recycling or Disposal

Depending on their condition, discs can be reused or recycled instead of thrown away.

Reuse

A good way to keep discs out of the garbage is to reuse them:

- Minor scratches can be repaired by rubbing a mild abrasive (such as toothpaste) on the non-label side of a disc in a circular motion from the center out. Also, some commercial refinishers can inexpensively repair your CDs.
- Unwanted CDs or DVDs can be sold to some stores, traded with friends, or donated to schools, libraries, or other organizations. Buying used CDs and DVDs or borrowing them from the library can also help reduce the environmental impact associated with manufacturing new products.

6 Useful Life

CDs and DVDs are created with materials that are extremely stable. If properly stored and handled, most discs will last for decades—and probably centuries. Certain conditions, such as high humidity, or extended periods of high temperatures, rapid temperature changes, and exposure to certain types of light, can damage discs and shorten their useful life. Taking care of your discs by keeping them out of direct sunlight and away from heat and water will help them last longer. Not only will you save money, but you will also reduce the discs' environmental impacts by preventing waste.



5 Transportation/Distribution

Once discs are packaged, they are ready to be sent to distribution centers, retail outlets, or other locations. Transportation by plane, truck, or rail requires the use of fossil fuels for energy, which contribute to climate change.



4 Packaging

CDs and DVDs are packaged in clear or colored plastic cases (jewel cases) or cardboard boxes—that are then covered with plastic shrink wrap. This packaging can be made from recycled or raw materials. For example, the plastic used can be from recycled bottles or from crude oil and natural gas extracted from the Earth and combined with chemicals.



3 Manufacturing

The manufacturing process described here is roughly the same for both CDs and DVDs.

- An injection molding machine creates the core of the disc—a 1-millimeter thick piece of polycarbonate (plastic).

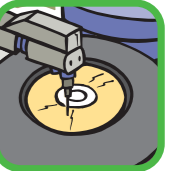
Polycarbonate is melted and put in a mold. With several tons of pressure, a stamper embeds tiny indentations, or pits, with digital information into the plastic mold. A CD-player's laser reads these pits when playing a CD.



- The plastic molds then go through the "metallizer" machine, which coats the CDs with a thin metal reflective layer (usually aluminum) through a process called "sputtering." The playback laser reads the information off of the reflective aluminum surface.



- The CD then receives a layer of lacquer as a protective coating against scratching and corrosion.



- Most CDs are screen printed with one to five different colors for a decorative label. Screen printing involves the use of many materials, including stencils, queegees, and inks.



Fun Fact

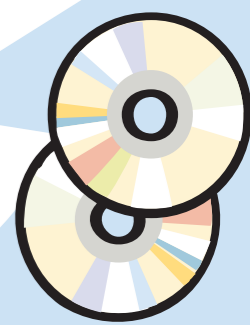
In 1983, when CDs were introduced in the United States, 800,000 discs were sold. By 1990, this number had grown to close to 1 billion!

Fun Fact

Every month approximately 100,000 pounds of CDs become obsolete (outdated, useless, or unwanted).

Fun Fact

The entire process of stamping a CD with digital information takes between 5 and 10 seconds.



Life Cycles

Why Are Product Life Cycles Important?

Each day, we use hundreds of products: clothes, shoes, books, newspapers, notebook paper, CD/DVD players, video games, cell phones, and TVs. Have you ever thought about what these products are made of, where their parts come from, or what happens to them when we're finished with them? Have you ever thought about the impact each of the products we use has on our environment?

Looking at a product's life cycle helps us understand the connections between the Earth's natural resources, energy use, climate change, and waste. Product life cycles focus on the processes involved in the entire production system—from extracting and processing raw materials, through the product's final use by consumers, recyclers, and disposers. By learning about product life cycles, we can see where and how everyone can collaborate to reduce the environmental impacts and natural resource use associated with a product. When we understand these connections, we can be better environmental stewards.

What Is a Life Cycle?

Just as living things are born, get older, and die, products also have a life cycle. Each stage of a product's development affects our environment in different ways—from the way we use products to the quantities of products we buy. Similarly, what we do with a product when we are finished with it has environmental effects.

The stages of a product's life cycle usually include:

Design: Engineers, designers, manufacturers, and others get ideas for products and then have to manufacture them. Most product designs are researched and tested before they are mass-produced. A product's initial design affects each stage of its life cycle, and therefore, its impact on our environment. For example, products designed to be reused instead of thrown out prevent waste and conserve natural resources.

Materials Acquisition: Whether man-made or naturally occurring, all products are made from some raw materials. "Virgin" materials, such as trees or iron ore, are directly harvested or mined from the Earth, which causes climate change, uses large amounts of energy, and depletes our natural resources. Making new products from materials that were used in another product—known as recycled or recovered materials—can reduce pollution, energy use, and the amount of raw materials we need to take from the Earth. For example, using recycled steel products instead of mining virgin iron ore saves 1,400 pounds of coal, 120 pounds of limestone, and enough energy to power more than 18 million homes for one year!

Materials Processing: Once materials are extracted from the Earth, they must be converted into a form that can be used to make products. For example, trees contribute the wood from

which paper is made. The wood is made into paper from several different manufacturing processes. Each separate process creates waste and consumes energy. For example, making one ton of recycled paper uses 64 percent less energy and 50 percent less water; reduces air pollution by 74 percent; saves 17 trees; and creates five times more jobs than manufacturing one ton of paper products from virgin wood pulp.

Manufacturing: Products are made in factories that use a great deal of energy. Manufacturing processes also create waste and often contribute to global climate change. Glass beverage containers, for example, can be used an infinite number of times, over and over again. More than 41 billion glass containers are made each year; recycling only one of those saves enough energy to light a 100-watt bulb for 4 hours. Imagine the energy savings from recycling all 41 billion containers. What's more, making 1 ton of glass from 50 percent recycled materials saves 250 pounds of mining waste.

Packaging: Many products are packaged in paper or plastic, which also undergo separate manufacturing processes that use energy and consume natural resources. While packaging can serve several important functions, such as preventing tampering, providing information, and preserving hygienic integrity and freshness, sometimes packaging is excessive.

Distribution: Manufactured products are transported in trucks, planes, trains, and ships to different locations where they are sold. Materials and parts used to make products are also transported to different places at earlier stages in the life cycle. All of these forms of transportation use energy and generate greenhouse gases, which contribute to global climate change.

Use: The way products are used impacts our environment. Reusable, durable, and recyclable products conserve natural resources, use less energy, and create less waste than disposable, single-use products. For example, fluorescent lamps reduce energy consumption because they are four to five times more efficient than incandescent bulbs. Reducing energy use also cuts down on power plant emissions that contribute to global climate change, acid rain, and smog. Properly caring for products also increases their useful life, so remember to read and follow the cleaning, operating, and maintenance instructions for the products you own—especially tires on your bicycles and other vehicles.

Reuse/Recycling: Recycling or remanufacturing products into new ones saves energy and reduces the amount of raw materials that have to be used in the manufacturing process. When products are reused or recycled, their life does not end; instead, it becomes a continuous cycle. For example, one pound of recycled paper can make six new cereal boxes, and five recycled soda bottles can make enough fiber fill to stuff a ski jacket.

Disposal: Throwing products in the trash ends their useful life. We simply lose these valuable resources outright. If we recycled all our morning newspapers, we could save 41,000 trees a day, and we could keep 6 million tons of waste out of landfills.

Crafty CDs and Designer DVDs

Do you own CDs or DVDs that you don't use anymore? Does your family receive software CDs in the mail that you don't want or need? Instead of throwing these discs away, why not use them to create something fun for yourself or a gift for a friend?

Sun Catchers and Windchimes

For a simple sun catcher you will need:

- Two discs (CDs or DVDs)
- Fine fishing line or thread
- Glue or Tape

Directions:

1. Cut the thread or fishing line to the length you want, and glue to the printed side of one disc.
2. With more glue or double-sided tape, stick the two discs together, shiny sides out.
3. Hang in a sunny window and enjoy the beautiful colors of the prism.

For more elaborate sun catchers or windchimes, you will need:

- At least six CDs or DVDs
 - Three to six feet of strong cord (a dark color is best)
 - A stopper like a washer for the suncatcher, or bell for the windchime—larger than the diameter of the hole in the CD—for each pair of discs.
1. Glue or tape each pair of discs together (be sure to leave the hole open). If you are going to hang your creation outside, use weatherproof glue or adhesive.
 2. Thread a stopper (or bell) onto the line about 1 inch from one end with a sturdy knot.
 3. Thread the first pair of CDs onto the line so that it rests on top of the stopper (or bell).
 4. Thread another stopper (or bell) onto the line about 1 inch from the CDs and secure with a sturdy knot.
 5. Repeat step 3 and 4 at intervals of about 3-5 inches, or whatever looks good to you.
 6. Hang your creation by a window and enjoy!

Drink Coasters

You will need:

- Four discs (CDs or DVDs)
- Self-stick felt (to keep the coasters from sliding) about 1/4 inch in diameter. You can buy felt this size or buy bigger pieces and cut them down.

Directions:

1. If need be, cut the felt into small round pieces about 1/4 inch in diameter.
2. Turn over the discs so the shiny side is facing down and the printed side towards you.
3. Stick 8 pieces of felt evenly spread around the disc
4. Turn the disc back over and place your glass or bowl on your new coaster.



Organize CD/DVD Reuse Events

- Set up a CD/DVD Swap Day at School
- Create a library devoted to CD/DVD-sharing
- Organize a CD/DVD recycling collection for community service or fund-raising projects

Cycle Scramble

Use the clue provided to help you unscramble the following words:

1. **RINDIV** Recycling products reduces the amount of _____ resources we have to use.
2. **SUE** Proper _____ of a product can prevent harm to humans and the environment.
3. **TAWSE** Reducing _____ is an important goal of understanding a product's life cycle.
4. **FILE LYCEC** A product's _____ consists of several stages, including design, manufacture, use, and disposal.
5. **LAIURNA** Products are made from _____ resources.
6. **DIGENS** The _____ of a product can influence its affect on the environment.
7. **VERODCEER** Making a product with _____ materials reduces its impact on the environment.
8. **SCIDESION** Making informed _____ when buying products can help prevent pollution.
9. **EDTATERC** Raw materials needed to make products have to be _____ from the Earth, which creates pollution.
10. **BLEADUR** Buying _____ products instead of disposable ones creates less waste.



1 virgin 2 use 3 waste 4 life cycle 5 natural 6 design 7 recovered 8 decisions 9 extracted 10 durable

The Big Debate: Reuse, Recycle, or Dispose?

CDs and DVDs are complicated products, which makes recycling or disposing of them just as complicated. This activity examines options for reusing, recycling, or disposing of CDs and DVDs at the end of their useful life. It can be a research project for individuals or assigned to teams for discussion.

1. What are some end-of-life options for CDs/DVDs? List the options and discuss the pros and cons of each.

pros	cons
_____	_____
_____	_____
_____	_____
_____	_____

2. Give a rough estimate of how long the components of a CD/DVD would last in a landfill. Use the chart below as a guideline:

Banana/orange peel	2-5 weeks
Leather	1 year
Newspaper	up to 50 years
Aluminum can	80-100 years
Plastic bottle	100-200 years
Glass bottle	1,000,000 years

3. Find out what CD/DVD manufacturers, recyclers, and local authorities have to say about end-of-life options for CDs/DVDs.
 - Conduct Internet research or call the company that produced your CD/DVD. Find out what it considers to be the useful life of the CD/DVD. Ask what the policy is for accepting its CDs/DVDs back for recycling or remanufacturing.
 - Find out what your school does with its CDs/DVDs at the end of their useful life.
 - Contact a local recycling center and ask if it accepts old CDs/DVDs.
 - Contact a CD/DVD recycler to learn about its recycling practices and what products are made from recycled CDs/DVDs.
 - Contact your local waste management agency and ask what its policy is regarding discarded CDs/DVDs.
4. After conducting this research, write a summary of your findings, including who you contacted, the date, and what information you obtained. Or, present the results to your classmates and discuss what you view to be a good end-of-life choice for CDs/DVDs.

Scavenger Hunt

Look around your home for the following life cycle-related items. Check off each item as you find it - how many can you find?

- This symbol stands for a type of plastic that can often be recycled and made into carpeting, automobile bumpers, or insulation for ski coats and sleeping bags.
- Item that you use at least three times before throwing it out.
- Item made from four different materials (e.g. wood, steel, plastic, aluminum, copper)
- Recycling bin.
- Something that can be composted—meaning it can break down, or decompose, into soil.
- Besides a CD, an item you can donate to charity instead of throwing away when you no longer want to use it.
- A product made from recycled paper.
- A product with excess packaging.
- This symbol stands for a type of plastic that can be recycled and made into traffic cones, toys, and laundry detergent containers.
- An item that is biodegradable—capable of being used as food by other living things and eventually gets turned into soil.
- Reusable container—can be used over and over again to store food or other items. It has a long, useful life.
- Item that you use once and then throw out.
- A plastic, paper, and canvas bag. Which of these has the longest useful lifespan?
- A product made from recycled glass.



Resources

Life Cycle Web Sites

U.S. Environmental Protection Agency, Product Stewardship Program
Explains the life cycle environmental impacts of products.
www.epa.gov/epf

U.S. Environmental Protection Agency, Green Engineering Program
Advocates designing products with their entire life cycle in mind.
www.epa.gov/opplintr/greenengineering/

U.S. Environmental Protection Agency, Design for the Environment
www.epa.gov/dfe

United Nations Environment Programme, Life Cycle Initiative
www.unepie.org/pc/sustain/lca/lca.htm

Society of Environmental Toxicology and Chemistry, Life Cycle Assessment Advisory Group
www.setac.org/lca.html

American Plastics Council
"Life Cycle of a Plastic Product"
www.plasticsresource.com/disposal/life_cycle_feature

The Steel Recycling Institute
"Steel Recycling Life Cycle"
www.recycle-steel.org
(Go to "Education," "Community Activity Sheets," "Steel Recycling Life Cycle")

Other Life Cycle Materials

"The Life Cycle of Everyday Stuff" (curriculum and poster)
www.nsta.org/pubs/nstapress/pb154x/faq2.asp
National Science Teachers Association
1840 Wilson Boulevard
Arlington, VA 22201

"The Quest for Less: A Teacher's Guide to Reducing, Reusing, Recycling."
Unit 1: Product Life Cycles,
U.S. Environmental Protection Agency, Office of Solid Waste.
www.epa.gov/epaoswer/osw/kids/quest/unit-1.htm
To order: www.epa.gov/epaoswer/osw/pub-q.htm or call 800 424-9346.

"A Web-Based Course Module on Automobile Recycling."
Chapter 4: Closing the Loop.
Georgia Institute of Technology's Environmentally Conscious Design
mime1.marc.gatech.edu/courseware/auto2/Default.htm

"The Life of a Hamburger: Play the Hamburger Game!"
(Covers paper and plastic packaging)
The Plastic Bag Association
www.plasticbag.com/KIDS/hamburger/play.html

Recycling Loop Poster: "Where Does Your Homework Go?"
American Forest and Paper Association/Project Learning Tree
Order at no cost at www.afandpa.org/kids_educators/index.html
(Click on "Teacher Tools", "Recycling Loop Poster")

CD/DVD Recycling Web Sites

Compact Disc Recycling Resources
The National Recycling Coalition, Inc.
This page provides a list of all the companies that recycle or remanufacture CDs.
www.nrc-recycle.org/
Go to the drop-down menu on the home page entitled, "How Do I Recycle?," then go to CD-ROMs.

Plug-in to Recycling Program
www.pluginrecycling.org
EPA, in partnership with Best Buy, AT&T Wireless, Dell, Panasonic, Sony, Sharp, Recycle America (part of Waste Management, Inc.), and ntxcycle, is helping consumers of electronic products tap into a network of recycling opportunities nationwide.

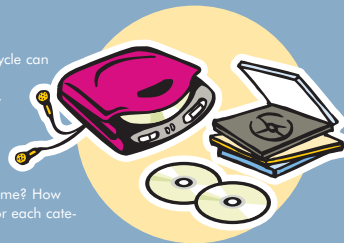
Sony's CD Recycling Web page
www.sony.co.jp/en/SonyInfo/Environment/ecaplaza/recycle_c.html

AuralTech CD Refinishing Specialists
www.nsynch.com/~auraltch/index.htm

GreenDisk Recycled Disks Web page
www.greendisk.com/
Green Disk's mission is to create recycled products from obsolete software. The company primarily accepts old CDs from corporations.

Student Survey

The front of this poster explains how the different stages of a CD or DVD's life cycle can affect the environment. Now think about the many ways you use electronics at school and home and how the life cycles of these items might affect the environment and the amount of garbage generated. Find out if your classmates are practicing waste reduction techniques by conducting a simple survey. How many of your classmates use rechargeable batteries in their portable CD players or handheld game systems? How many sell used CDs to a used music store? How many borrow DVDs from the library? How many students own a computer at home? How many students go to the library to use a computer? Calculate the percentages for each category and make a graph or chart of your results.



Things You Can Do